MATH2340 Essay 1

Investigate the microtonal scales of Harry Partch.

1 Introduction

In this essay I will discuss Harry Partch's ideas around tuning systems, Partch was a composer from America and started composing in the early 20th century, having rejected 12-tet as a tuning system he sought to develop his own, based on just-intonation. Having grown up around a mix of cultures as his parents were missionaries and worked for the immigration service Schell (2018) it's not a surprise that he had a lot of world influence in his music. The first composition, 17 Lyrics of Li Po is an adaptation of the Chinese 8th century poet Li Po.

Further I will discuss how limits work, how Partch visualised them and other possible visualisations of the harmonics and their complexities. These can be powerful tools for composing music. Finally I will look at Partch's instruments and other artist's interpretation of them.

2 Discussion

Harry Partch's scales are just intonation, that is that each interval is tuned as a ratio of small whole numbers. Partch introduced the concept of 'limit' that is, a limit on the ratio of intervals. For example: Pythagorean tuning is 3-limit in Partch's book *Genesis of a Music* he talks about Pythagorean dividing a string into two and then into three but would not divide the string into five; 5 is chosen because it is the next prime, 4 is divisible by 2. This sets up the 3 limit or as Partch calls it here 'the 3 idea'. (Partch, 1979, p. 399)

Partch defines ratio as both a tone and interval at the same time, that being that the denominator represents some base (unity), and the numerator is some modifier of that. $\frac{2}{1}$ represents a doubling and thus is an octave.

A limit (in Partch's book) or now, odd-limit, is more accurately the largest odd number that divides either the numerator or denominator. In 3-limit all of the intervals are based on the $\frac{3}{2}$ ratio so that we have $\frac{1}{1}, \frac{4}{3}, \frac{3}{2}$ as the intervals, $\frac{4}{3}$ is the inversion of $\frac{3}{2}$. Further everything in a q-limit, in just intonation is $2^{\mathbb{Z}}\frac{u}{v}$ where $u, v \leq q$. Essentially a limit is intervals whose numerators and denominators where factors of two are removed are less than or equal to q.

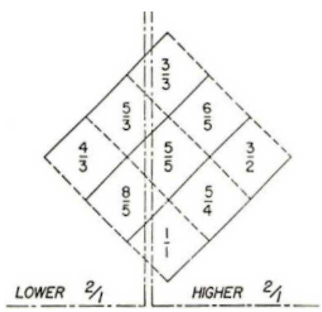

Figure 1: 5 Limit Tonality Diamond (Partch, 1979, p. 110)

Thus we can generate more limits, for example the 5-limit consisting of all of the previous odd-limit intervals and the new one's generated by the above process. Each limit with an increased upper bound will contain the other limits as subsets. So 5-limit contains 3-limit which contains 1-limit. Partch developed the idea of a 'tonality diamond' to display the limit in an arbitrary but nicely graphical way. This graphic shows a few things, through the middle are all the ratios such that the pitch remains the same ($\frac{1}{1}, \frac{5}{5}, \frac{3}{3}$). The diamond is arranged such that the numerator of the ratio is decided by the pitches' diagonal lower-left to upper-right position. The ratios in the first row diagonally left have a numerator of 1, the middle have 5 and the top has 3. The denominator is decided similarly however by the pitches' lower-right to upper-left position Ekman (2011).

Where there are solid line between intervals is where a triad is formed. Where ratios are based on 1 or a doubling of 1, there is unity, where there are 3 of a doubling of three there is unity and so on (Partch, 1979, p. 110).

Finally we get to 11-limit, which is the limit that most of Partch's music is written in. Partch created a 43 tone scale based on the 11-limit, filling out the missing intervals with products of ratios in the 11-limit with great care. The smallest interval in the 11-limit 43 tone scale Partch uses is 14.4 cents. Further, the 11th harmonic hadn't been incorporated into western music. This leads into an idea in music theory of the emancipation of dissonance, that is to quote Schoenberg "As the ear becomes acclimatized to a sonority within a particular context, the sonority will gradually become 'emancipated' from that context and seek a new one." as Partch has pushed for 11-limit such after have pushed for higher and higher limits, some composers are making pieces extreme limits now, the space between intervals getting smaller and more dense as a whole.

Using 11-limit as an example we can also discuss dimensionality or rank for each tuning system. This is how many independent intervals can be combined so for 11-limit the primes are 2, 3, 5, 7, 11 thus it is rank 5. For example an n-tone Equal Temperament system would be rank 1. This is a reflection of the harmonic complexity of the tuning system. Further this can be expanded into a 'Harmonic Lattice Diagram' as described by Joe Monzo Monzo (1998). These diagrams use each prime as a different dimension as above by plot them in a way such that they nicely convey information about consonance and harmonics. $\frac{1}{1}$ is central with all other intervals radiating from it, the angle is decided by the cents value of the prime, the example Monzo gives "31, which is the ratio 3/2 and is 702 cents, has a vector radiating from 1/1 at very close to 1 o'clock position (because 6 + 7 mod 12 = 1)" Monzo (1998). Vectors' lengths are also based on the prime with 3 being the shortest. As opposed to Partch's diamonds these diagrams show how much more complex each iteration of the odd-limit gets. Also Monzo introduces a notation for intervals in a given limit *Monzos* these describe a prime vector thus relating to the lattice. For 5-limit we can show $\frac{1}{1}$ with $|0\ 0\ 0>$ which is $2^0 \times 3^0 \times 5^0$ and $\frac{3}{2}$ with $|-1\ 1\ 0>$ which is $2^{-1} \times 3^1 \times 5^0$. This expands out so in 11-limit there are all 5 primes, $|-1\ 3\ 0\ 0\ \ -1>$ is $\frac{27}{22} = 2^{-1} \times 3^3 \times 5^0 \times 7^0 \times 11^{-1}$. These each describe a vector that extends from $|0>$ using prime numbers and powers as the coordinates, this encapsulates the idea of each limit having a higher dimensionality. Of course, using odd-limit 9-limit is present but not prime $(9 = 3 * 3)$ so does not add another dimension.

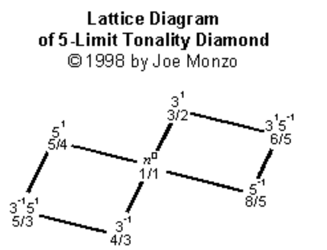

Figure 2: 5 Limit Harmonic Lattice

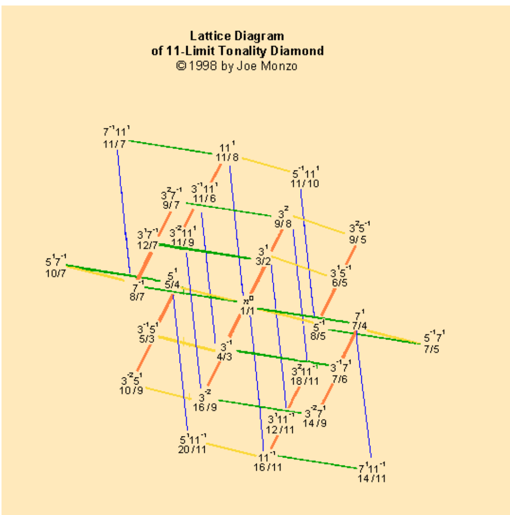

Figure 3: 11-limit Harmonic Lattice with colour to show link

Figure 4: Sygygys Organ Syzygys (2007)

Partch was an instrument-maker, and rightfully so to be able to play his own scales. Most of the instruments he made couldn't play all 43 tones in his scale. One of his instruments, the diamond marimba directly displays the 11-limit tonality diamond through the placement of tuned wood blocks in a diamond reminiscent of the diamond he created in diagram. Further, other versions have been made with 13-limit tonality diamonds (with extra blocks for other consonances such as $\frac{2}{1}$. Partch also adapted an organ, the chromelodeon, this was a retuned organ that's scale of one octave spanned three and a half octaves on the keyboard. Syzygys, a Japanese microtonal avant-pop band have also made an adapted organ to play Partch's scale and more information about the development is available. They had made a keyboard that has 61 keys, and all but 3 are taken up by the scale stretching from F2 to F5 on the keyboard. There are also positions marked for chords that they use in their music Syzygys (2007). The cloud chamber bowls are bell-like glass 'bowls' made from carboys used in a radiation laboratory, some of these were used in another instrument "spoils of war" which also includes shell casings. The Quadrangularis Reversum has a reversed version of the diamond marimba and a some more blocks to have more sounds; originally meant to use a special genus of square bamboo but instead using circular bamboo for resonators. Many of his instruments use scavenged materials and are light-hearted.

3 Conclusion

Partch carefully constructed his scale according to the harmonic series and an awareness of music in general which made for an interesting sound; when listening to his music it does sound alien and definitely at least different from the western 12-tet composed pieces. The instruments that he created are also uniquely creative and show a strong link from his theoretical background to a physical manifestation of it. Practically creating a tonality diamond is also a good way to demonstrate the tuning system to other people, which he did to display the strength of his tuning system.

Partch opened the door for a generation of microtonal musicians who use just-intonation and many pieces have been made with limits higher than 11-limit since. The theoretical framework he left behind has also been useful for expansions such as Joe Monzo's Harmonic Lattice. Partch's scales have been employed in other music since, notably in the Syzygys' work which shows how flexible it is, moving it from Partch's own style to one more in line with popular music and things like bossa-nova.

References

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